RESEARCH ARTICLE

Use of Ravage Lovastatin as a Non-Toxic Corrosion Inhibitor for Copper in the 3M H_2SO_4 Solution

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ABSTRACT: The ravage Lovastatin drug was evaluated to screen its effectiveness to protect the copper corrosion in 3 M sulfuric acid solution. The weight loss, colorimetry and atomic absorption spectroscopy was employed to study the influence of ravage Lovastatin drug. The result showed that, ravage Lovastatin drug act as good copper corrosion inhibitor and remarkably reduces the copper corrosion density property. The utmost corrosion inhibition (protection) efficiency observed at 400 ppm. Further, electronic property of ravage Lovastatin drug was studied by using the Argus Lab software and surface studies was screened with the help of scanning electron microscopy (SEM) studies.

KEYWORDS: Ravage Lovastatin drug, Weight loss, Colorimetry, Atomic absorption Spectroscopy.

https://doi.org/10.29294/IJASE.6.1.2019.1233-1238 **© 2019 Mahendrapublications.com, All rights reserved**

1. INTRODUCTION

Copper widely used in construction, equipment and metal processing units due to its interesting properties. Acid cleaning treatment with the help of sulfuric acid is used for eliminating the surface impurities, scales, oxides from the copper surface in a numerous industrial applications [1-3]. As a result, it is required to mitigate the severe disintegration process during the exposure to the sulfuric acid systems. Different strategies have been greatly employed in the fight against the corrosion of copper. These include application of corrosion inhibitors, coatings, cathodic protection, anodic protection, and design materials selection. Of all these, the corrosion inhibitors is easiest and cost effective to apply. The search for eco-friendly, cost efficient and innovative inhibitors is still an ongoing route. One effective method for eliminating the copper corrosion process is the introduction of small amounts of electron rich elements to the sulfuric acid system. Most of the compounds containing P, S, N and O atoms exhibit anticorrosion property. This is due to the adsorption property of such compounds over the metal surface. The anticorrosion inhibition property of organic species is mainly depends on their interaction with the metal surface [4-7]. Use of Schiff bases, phenothiazine, amino acids, imidazoles, triazoles, phosphate, molybdate and chromate has been restricted due to expensive and toxic behavior. Efficient and economical corrosion inhibitors are urgently required for the different industrial sections. The use of toxic corrosion inhibitors which are dangerous to the eco-system and human health has been strongly restricted by numerous international agencies. Hence, non-toxic compounds have attracted the corrosion scientist's attention. The corrosion scientist focuses on the utilization of expired drug products. Most of the ravage drug products unfit for the consumers but expected to show anticorrosion property on the metal surface. The expired drug possessing P, N, O, S and double and triple elements in their moiety which actively involved in the adsorption process. Generally organic species are adsorption type corrosion inhibitors and adsorb over the surface of copper metal and suppress the metal dissolution reactions [8-13]. The adsorption behavior of expired drug species is mainly related to the possessing of P, S, N, O and π-electrons in expired drug structures. In most cases, the adsorption inhibitor blocks the both anodic & cathodic corrosion reaction [14-20]. Compared to the inorganic and polymeric species, the ravage drug has low toxic nature, and having the better layer-forming capacity on the metal surface. In this context, ravage Lovastatin drug containing O and pi-electrons in their structure have been selected and studied extensively its anticorrosion behavior on copper in the 3 M sulfuric acid system by using the weight loss, colorimetry and atomic absorption spectroscopy (AAS) techniques. Quantum chemical and surface studies were also screened in order to support the current findings.

2. EXPERIMENTAL SECTION

The studied copper metal containing (wt. %): The copper metal cut into the square shape. Ravage Lovastatin drug was obtained from the local area and concentrations of 100 ppm, 200 ppm, 300 ppm and 400 ppm was prepared for the corrosion studies. The

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Received: 19.06.2019 **Accepted:** 18.07.2019 **Published on**: 28.08.2019

3M sulfuric acid is prepared as per the standard procedure. The weight loss, colorimetry and atomic absorption spectroscopy experiment was performed on the 100 ml of 3 M sulfuric acid solution. The weight loss, colorimetry and atomic absorption spectroscopy experiment was performed using the 100 ml of 3 M sulfuric acid solution in the 250 ml capacity beaker. The protection efficiency of the corrosion inhibitor can be evaluated by using the weight loss, colorimetry and atomic absorption spectroscopy techniques.

3. RESULTS AND DISCUSSION

3.1 Weight loss technique

It is well know that, gravimetric (weight loss) technique is classic method to investigate the surface coverage and protection efficiency. The protection of copper in the 3 M sulfuric acid involving four different amounts of Ravage Lovastatin drug was carried out after the 10 hours immersion time at five different solution temperatures 303 K, 313 K, 323 K, 333 K and 343 K. The protection efficiency values obtained from the weight loss technique are presented in the Table 1. The protection efficiency enhanced with rise in the ravage Lovastatin which implies that, protection of corrosion reaction which is due to the ravage Lovastatin adsorption on the copper in the 3 M sulfuric acid system. The adsorption leads to the film formation over the copper surface in the 3 M sulfuric acid system. It can be seen that, the protection efficiency is high at higher inhibitor concentrations. This effect is influenced by increase of strength of adsorption reaction at high amounts of expired drug. Low surface kinetic energy is due to the high rise in the concentration of inhibitor which favors the adsorption process. The solution temperature is vital factor to be thoroughly studied to understand the Ravage Lovastatin drug-3 M sulfuric acid system. Ravage Lovastatin drug effectively act as a barrier for the copper corrosion process and large protection of copper was evidenced at 400 ppm of Ravage Lovastatin drug. This nature is due to the adsorption of Ravage Lovastatin drug over the surface of copper in the 3 M sulfuric acid system. The surface coverage enhances with rise in the Ravage Lovastatin drug concentration, giving better protection efficiency. The adsorption of Ravage Lovastatin drug species leaving less copper active sites that is available for the dissolution process. The rise in the solution temperature generally decreases the protection efficiency of the Ravage Lovastatin drug on the copper surface in the 3 M H_2SO_4 system. This nature is due to the desorption of Ravage Lovastatin drug over the copper surface in the corrosive environment. At higher solution temperature, desorption plays vital role compared to adsorption process. The process of desorption damages the protective film of Ravage Lovastatin drug on the copper surface in 3 M sulfuric acid system. As a result of this, the free copper metal is exposed to the sulfuric acid system. Hence, weight loss of copper metal increases with rise in the solution temperature. The highest protection efficiency (98.765) observed at 303 K with 400 ppm of ravage Lovastatin drug.

3.2 Colorimetry

The results of colorimetry are shown in the Table 2. From the table 2, it is clear that, low amounts of Ravage Lovastatin drug significantly protects the copper surface that enhances the protection efficiency of the Ravage Lovastatin drug over the copper surface in the 3 M sulfuric acid system. The electrostatic interaction between the ravage Lovastatin drug (positively charged)- copper surface (negatively charged) leads to the formation of insoluble protective layer which enhancing the copper corrosion inhibition by hindering the attack of corrosive ions. The copper metal is protected by increase in the concentration of Ravage Lovastatin drug over the copper surface in the sulfuric acid system. The weight loss of copper reduces with rise in the protection efficiency of the Ravage Lovastatin drug. This is due to the adsorption coverage of Ravage Lovastatin drug species on the copper surface in the 3 M sulfuric acid system. The protective layer formed from the Ravage Lovastatin drug blocks the copper corrosion reaction, which prevents the attack of copper surface in the 3 M sulfuric acid system. The results obtained from the colorimetry technique are in good in agreement with the weight loss results.

3.4 Quantum chemical studies

Quantum chemical studies were also carried out in order to support the corrosion protection behavior of Ravage Lovastatin drug on the metal surface in the corrosive medium through ArgusLab software via PM3 method. The results are shown in the Figure 1. Large the value of E_{HOMO} value, greater will be the tendency of the organic species to donate the electrons, while the lower E_{LUMO} values indicates the capacity of organic species to obtain electron from the copper surface. In present investigation, the $-E_{HOMO}$ (0.552355) is higher than the $-E_{LUMO}$ value (0.314899), which shows the electron donation property of Ravage Lovastatin drug. The quantum chemical studies clearly indicates that, the Ravage Lovastatin drug easily donate the electron to the active copper sites for the formation protective layer on the active copper sites in the 3 M sulfuric acid system, which is responsible for the corrosion inhibition process on the copper surface.

Table 1 Weight loss (Gravimetric) at different solution temperatures

Concentration (ppm)	Contact time (h)	Protection (corrosion inhibition) efficiency (303 K)	Protection (corrosion inhibition) efficiency (313 K)	Protection (corrosion inhibition) efficiency (323 K)	Protection (corrosion inhibition) efficiency (333 K)	Protection (corrosion inhibition) efficiency (343 K)
Bare	10	54.321	50.311	49.450	48.008	45.451
100		66.786	60.150	56.153	54.150	52.153
200		76.783	73.874	70.873	67.875	65.873
300		98.765	97.876	93.630	90.633	88.634
400						
Bare	20	52.112	48.110	44.987	44.567	43.116
100		63.003	59.007	48.007	50.008	48.006
200		73.141	72.143	70.145	65.180	63.141
300		94.063	90.061	88.067	84.164	82.061
400						
Bare	30	50.230	48.236	47.237	42.231	40.235
100		60.143	56.143	54.148	53.147	47.141
200		70.810	68.813	65.815	62.870	60.816
300		91.120	90.120	89.987	86.128	83.126
400						
Bare	40	48.120	46.120	43.127	41.129	40.127
100		53.355	54.301	50.387	53.135	52.350
200		68.003	65.005	63.008	67.005	63.004
300		89.140	87.140	85.140	83.140	80.172
400						

Table 2 Colorimetry results

Concentration (ppm)	Contact time (h)	Protection (corrosion inhibition) efficiency (303 K)
Bare	10	53.459
100		58.150
200		68.870
300		96.631
400		
Bare	20	56.143
100		57.003
200		74.140
300		92.060
400		
Bare	30	52.230
100		55.143
200		70.810
300		90.111
400		
Bare	40	48.120
100		50.350
200		69.001
300		87.143
400		

Table 3. Atomic Absorption Spectroscopy results

Concentration (ppm)	Contact time (h)	Protection (corrosion inhibition) efficiency (303 K)
Bare 100 200 300 400	10	54.451 63.150 68.878 96.680
Bare 100 200 300 400	20	50.190 60.003 66.140 93.060
Bare 100 200 300 400	30	48.236 57.140 65.811 90.120
Bare 100 200 300 400	40	47.120 53.350 63.003 87.140

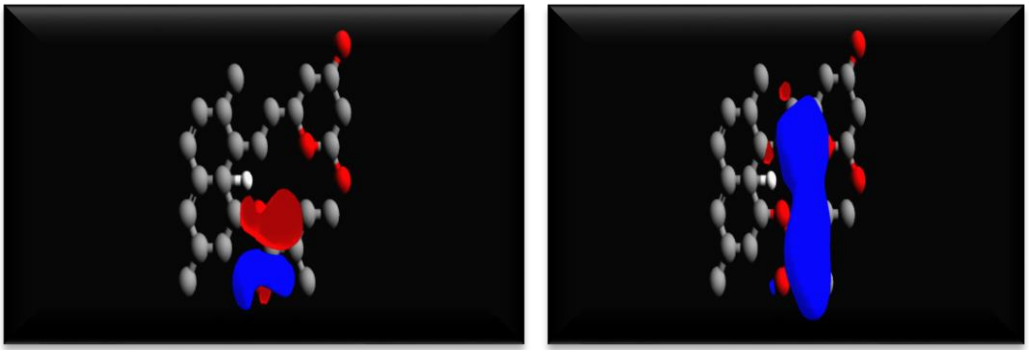

Figure 1: E HOMO and E LUMO of Ravage Lovastatin drug

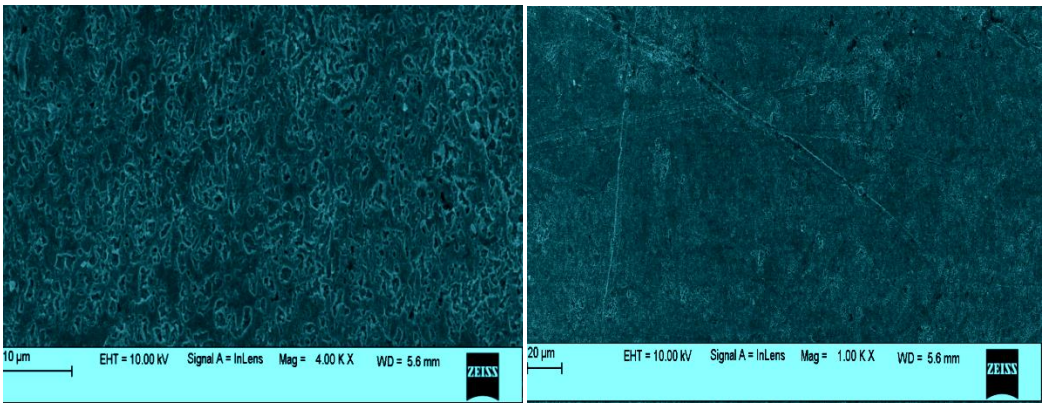

Figure 2 (a, b): SEM images without and with inhibitor

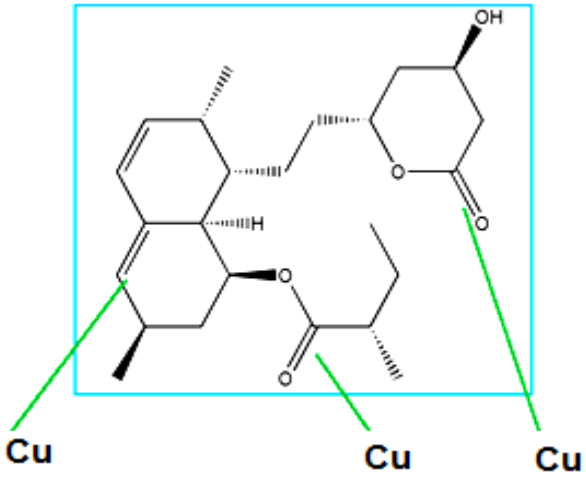

Figure 3: The adsorption of Ravage Lovastatin drug on the copper in the 3 M sulfuric acid system

3.5 Scanning electron microscopy technique

The scanning electron microscopy (SEM) photography of copper without and with 400 ppm of Ravage Lovastatin drug is shown in the Figure 2 (a, b). From this, it is clear that, the copper surface is very rough with irregular pits, which shows that, the copper surface in the sulfuric acid system is highly corroded. In contrast, the presence of 400 ppm of Ravage Lovastatin drug, the copper surface significantly improved without any pores excluding polishing lines. The deviation in the copper surface after the addition of 400 ppm of Ravage Lovastatin drug is due to the presence of insoluble protective layer on the copper surface in the 3 M sulfuric acid system. This clearly confirms the protection of copper corrosion process in the 3 M sulfuric acid system.

3.6 Mechanism of corrosion inhibition

In sulfuric acid system, the transition of copper-3 M sulfuric acid solution interface is due to the adsorption of Ravage Lovastatin drug molecules at the copper-3 M sulfuric acid solution interface, generating a insulating layer on the copper surface. The weight loss studies show that, the rise in the solution temperature decreases the protection efficiency of the Ravage Lovastatin drug. The decrease in the protection efficiency with rise in the solution temperature clearly shows the physical interaction of Ravage Lovastatin drug species on the copper surface in the 3 M sulfuric acid system. The presence of double bond in between the C= C and C=O bond of Ravage Lovastatin drug species actively involved in the formation of physical protective layer on the copper surface in the 3 M sulfuric acid system. The formation of physical protective layer takes place through the replacement of water molecules from the copper surface by Ravage Lovastatin drug species at the active copper-3 M sulfuric acid system [Figure 3].

4. CONCLUSION

The concentration influence of Ravage Lovastatin drug on the corrosion of copper in the 3 M sulfuric acid system was studied by using the weight loss, colorimetric and atomic absorption spectroscopy techniques. It was observed that, introduction of four different amounts of Ravage Lovastatin drug on the copper surface in the 3 M sulfuric acid solution greatly decreases the weight loss of copper in the 3 M sulfuric acid system. The rise in the solution temperature negatively effect on the protection efficiency of the corrosion inhibitor. This nature is due to the desorption of Ravage Lovastatin drug species over the copper surface in the 3 M sulfuric acid system. The results of colorimetry and atomic absorption spectroscopy technique fully support the weight loss technique.

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